

(17)**Cluster Analysis of Signals Obtained by Simulation of TOFD Technique for Pattern Recognition of Welding Defects**

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Nondestructive evaluations are widely used to verify the existence of discontinuities within the material. Among nondestructive testing, the time of flight diffraction (TOFD) technique allows high speed of inspection and high probability of small discontinuities detection into the material. However, welding defect classification from ultrasound signals acquired during an inspection requires a highly skilled professional and, considering the volume of data to be analyzed, a long time. This task may be performed by pattern recognition or clustering algorithms able to quickly process a large amount of data. In this work, three types of well-defined welding defects (lack of penetration, pore and crack) were modeled. Then, a two-dimensional wave propagation simulation was performed to produce a set of typical A-scan signals of each kind of discontinuity studied. Finally, the k-means clustering, an automatic classifier with unsupervised learning algorithm, was applied to check how the simulated signals would be separated. Some clustering evaluation indexes can be applied to decide how many clusters should be used. In this paper, the Silhouette and Davies-Bouldin indexes were evaluated to help this decision. Both indexes try to measure how well different clusters are separated from each other and how well elements of a same cluster are grouped. Although the optimum number of groups suggested by k-means differs from the number of classes regarded in modeling, the clustering obtained reveals some pattern. This work helps us to understand the influence of experimental parameters as well as it is the first step to achieve a verisimilar simulation needed to produce a dataset able to successfully train a supervised classifier to be later used in classification of true signals.

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